LINKS TO INDUSTRY

Counting on Technology for Help Up the Economic Ladder

D. NORMILE

Pulp fact. Ernesto Lozada milks low technology to help coconut farmers.

LOS BAÑOS, THE PHILIPPINES—The coconut-oil processing plant chugging away on campus is decidedly low-tech: It first dries and grinds the coconut meat and then presses the pulp to extract the milky-white oil. Yet its simplicity is what most pleases the machine's developer, Ernesto Lozada, dean of the college of engineering at the University of the Philippines, Los Baños. Local machine shops can make it, and workers can learn quickly how to operate it. Most importantly, the 15 agricultural cooperatives that have set up similar mills over the past 2 years now have an alternative to selling their raw coconuts to giant international traders. And selling a processed product could put more money in farmers' pockets.

Like it or not, the farms, factories, and businesses here and across Southeast Asia are increasingly knit into a global economy. And they will have to climb the technology ladder to compete successfully. That requirement is driving the steady rise in government spending on R&D throughout the region. "We realized that we needed to move into improving the interface between research and the private sector, to support the thousands of small and medium-sized companies that provide jobs and fuel the economy," says Tan Sri Omar Abdul Rahman, science adviser to the prime minister of Malaysia. "And government has to play a bigger role in a developing country," he adds. "Without that push, we would still be planting rubber trees and digging for tin."

In drawing up their R&D portfolios, government officials want to strike the right balance between applied and basic research, in particular between a desire by researchers to do world-class science and the country's need to develop technology appropriate to local industries. And despite an urge to rush into the 21st century (see sidebar on p. 1481), their starting point is usually the region's natural resources.

Lozada's coconut-oil mill is just the latest in a string of improvements in process manufacturing from his lab. In each case, his goal is to put local producers on the first rung of the technological ladder and to teach farmers and factory hands that technology is a tool for adding value to their raw materials and products. "That culture has not been brought [home] to us," he says.

In Indonesia, the idea of applying science to solve economic problems began with a modest request from the president for the nation to become self-sufficient in rice, recalls geologist John Katili, recently retired vice speaker of Indonesia's Parliament and a former director-general of the Department of Mines and Energy. Its success, he says, "made

PROFILE

Shaking Up a Seismology Institute

QUEZON CITY, THE PHILIPPINES—In a sense, Raymundo Punongbayan spent nearly a decade preparing for the 1991 eruption of Mount Pinatubo. And when it blew—in one of the century's biggest volcanic events—Punongbayan and the Philippine Institute of Volcanology and Seismology were ready.

In the old days, staff members at the forerunner of what's known as Phivolcs recorded changes in geologic conditions "without trying to understand the underlying processes," says Ernesto Corpuz, the institute's chief monitoring scientist. But that passivity disappeared when Punongbayan became director in 1982. Soon, staffers were headed overseas for advanced degrees—Punongbayan was the only one on the staff with a Ph.D., which he received from the University of Colorado, Boulder, in the early 1970s—and research was part of every scientist's job description. In addition, Phivolcs was no longer a lonely outpost atop one of Earth's most active faults: Scientists were arriving from all over the world, bringing the latest techniques and equipment. "Now we try to relate [what we see] to what is going on beneath the ground," says Corpuz.

When Punongbayan, 60, left the University of the Philippines, Diliman, to take charge of Phivolcs, he promised "to deliver what we're supposed to deliver," referring to the institute's mission to keep tabs on the country's two dozen or so active volcanoes and other seismic activity. In early 1991, when Mount Pinatubo began rumbling, Phivolcs's staff could see a big one coming. However, with limited instrumentation on hand, Punongbayan turned to the U.S. Geological Survey (USGS) for help. As its understanding of the precursor events increased, Phivolcs repeatedly enlarged the size of the area that it recommended be evacuated, eventually to a radius of 30 kilometers. That advice saved thousands of lives when Pinatubo exploded on 12 June.

ALBERTO GARCIA

Irresistible force. Raymundo Punongbayan aims for world-class science.

Although USGS scientists have received much of the credit for their work, Chris Newhall, a USGS volcanologist at the University of Washington who headed the USGS team, insists it was a joint effort. "The truth is, neither team could have done it by itself," he says. "[Punongbayan] has really done quite a remarkable job in turning Phivolcs from what was a small, sleepy bureau that did no research at all into a very active group."

Since Punongbayan's arrival, six staffers have earned Ph.D.s and 10 more are pursuing advanced degrees. He hopes their training will enable the institute to take advantage of the natural laboratory under its feet. "This is one field where I think Filipinos can excel and be recognized internationally." –D.N.

people recognize that science could be valuable in helping solve the country's economic problems."

Over the years, the region's technology policy has become more sophisticated. But it has largely retained its focus on areas where scientists and government policy-makers see a natural advantage for their country. In the Philippines, for example, two separate government panels set up at the beginning of Fidel Ramos's presidency 6 years ago each concluded that a handful of broadly defined areas—marine products, fruits and flowers, ceramics and other materials—could produce "export winners," says William Padolina, secretary of the Philippines' Department of Science and Technology.

Common targets. That list is a familiar one to policy-makers in the region. To a large extent, all four countries in this special survey have zeroed in on the same fields: biotechnology, for its impact on agriculture and forest products; materials science, for its connection to rubber and ores; and biodiversity, for possible payoffs in chemical and medicinal compounds gleaned from the region's wealth of still-undiscovered flora and fauna. "Everyone thinks they have a natural advantage in one area that they can develop into a technological strength," says Yongyuth Yuthavong, director of Thailand's National Science and Technology Development Agency. "Of course," says Yuthavong with a smile, "Thailand really does have an advantage in biotechnology because of our biodiversity."

One exception to the policy of focusing on areas of comparative advantage has been Indonesia's controversial push to develop an aircraft industry, led by Research and Technology Minister B. J. Habibie. An aeronautical engineer, Habibie "didn't think that our economy should depend on natural resources to become stronger," Katili explains. "His philosophy was: If you can build a jet plane, then you can build a bicycle." The goal was to tackle the development of a very sophisticated end product and then work to build up the high-tech industry and scientific infrastructure needed for it.

The heavily subsidized approach has bolstered the country's confidence in its ability to tackle technological challenges, says biochemist Sangkot Marzuki, director of the Eijkman Institute in Jakarta. And it is a technique that can be applied to other high-priority sectors, including shipping and biotechnology, adds mycologist Mien Rifai, assistant research and technology minister for development under Habibie.

But others say the project has provided few spin-offs for other sectors. "Nothing has trickled down. That's not how nature works," says Teuku Jacob, a forensic anthropologist and former rector of the University of Gadja Madah in Yogyakarta. "You start with the roots, and the roots suck up the water to the leaves."

J. MERVIS

From the start. John Katili wants a stronger scientific base.

Katili expresses similar doubts. "I don't think you can start at the end. You need to start at the beginning and build up the scientific infrastructure."

J. MERVIS

Top-down. Tan Sri Omar Abdul Rahman says government must help private sector.

Calling the shots. As governments in the region increasingly direct their scientific resources toward priority areas, they are facing the question of just how much to let scientists follow their curiosity and how strongly to direct research. Most are opting for a top-down approach. Take Malaysia's Intensifying Research in Priority Areas program. In the beginning, the agency allowed scientists to set priorities. But now research officials have firmly grabbed the reins. "What have our scientists achieved for all the investment in biotechnology that we have made? The answer is, very little," says Malaysia's Omar. Although the government now sets the objectives, he says, "it will not tell people how to get there. That part is still up to the scientists."

Policy-makers and scientists throughout the region generally agree that curiosity-driven basic research is valuable, but governments with limited science budgets are giving priority to more ap-

Betting on a New Silicon Valley

KUALA LUMPUR, MALAYSIA—Fifteen years ago, Makhdzir Mardan was a pollination biologist working with bees at Malaysia's national agricultural university. Now he's director of the school's CyberCreative Lab, which is drawing up plans to join with Silicon Graphics on a $500,000 state-of-the-art educational animation studio.

Makhdzir is riding a wave of government investment in one of the most grandiose high-tech schemes in Southeast Asia: an Asian Silicon Valley—complete with a paperless city and "smart" schools equipped with the latest technology—that would extend south from the capital for 50 kilometers to a new international airport set to open this summer. The Multimedia Super Corridor (MSC) project hopes to attract technology-intensive companies to the site, foster partnership with global communications giants, and spur innovation among all sectors of the domestic economy.

Although the current fiscal crisis could slow development of some parts of the plan, universities throughout the country are still jockeying for position to reap the rewards of this information technology (IT) extravaganza. "The next stage of growth is to move from manufacturing into the IT phase, and MSC is the way to do it," says Tan Sri Omar Abdul Rahman, science adviser to the prime minister.

Taking the lead by virtue of its location is the University Putra Malaysia (UPM), whose 3000-hectare campus sits within the corridor. And Makhdzir isn't the only one who has shifted course to bring himself in line with MSC. Last year, the university itself changed the meaning of the "P" in its name from Pertainian, which means agriculture in Bahasan Malay, to the name of the country's first prime minister.

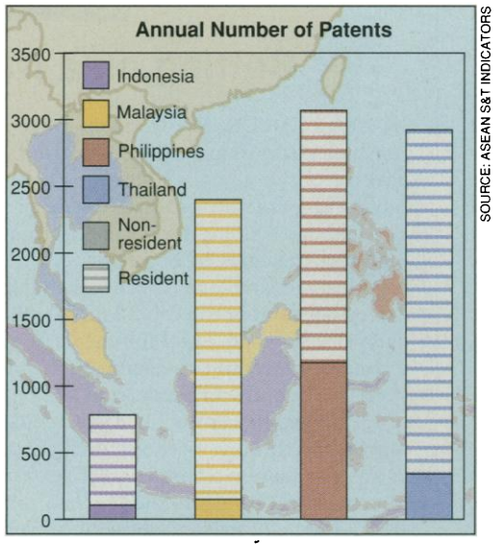
"Pertainian doesn't fit anymore," says Makhdzir, who a decade ago volunteered to help plan the first computers on campus and wound up becoming point man for IT-related activities, which include SPARC workstations on the desk of every faculty member. "But we haven't abandoned our strengths. With IT, our emphasis on bio-based research can be converted into a focus on bioinformatics." Along with their colleagues at other universities, UPM faculty members are also designing computer-based curricula for students who will attend model schools within the corridor, as well as training modules for the teachers who will instruct them.

For the average academic scientist, however, MSC serves more as a symbol of the government's commitment to high technology than as a source of research support. "The government has made it clear that the goal [of higher education] is not to produce workers for the IT industry," says science educator Rudin Salinger, a senior adviser to MUST (see sidebar on p. 1474), "but rather to produce people who are computer literate in all sectors of the economy." –J.D.M.

plied programs. "The policy is for greater emphasis on applied research," says V. Danabalan, secretary-general of Malaysia's Ministry of Science, Technology, and the Environment, in a comment that echoes the views of his peers in other countries. "In areas where we need to be strong to advance our priorities, we will support basic research, too. But research for its own sake is not something that we can afford."

However, putting an emphasis on applied research can leave academics feeling pulled in different directions. Promotion at most universities remains heavily weighted toward publications, and many researchers would like to see equal weight given to the extension work with farmers or joint work with industry. "Solving a practical problem is better than producing one publication that nobody reads," says Teresita Espino, a molecular biologist at the National Institute of Molecular Biology and Biotechnology, a part of the University of the Philippines, Los Baños.

And some professors think that the pendulum has swung too far toward immediate economic payoffs. "If they want to build up an electronics industry, they should be funding work in semiconductor physics," says W. C. Fon, a nuclear physicist at the University of Malaya and co-winner last fall of his country's Scientist of the Year award. "The pool of knowledge is drying up, and the 21st century will belong to those who are doing fundamental research. Unless you are able to improve the technology," he warns, "you won't succeed in the long run."



SOURCE: ASEAN S&T INDICATORS

Patents pending. Most patent applications come from foreign entities.

Industrial-strength programs. To many government officials and scientists, the most critical issue is not what kinds of government research would best benefit the economy, but how to strengthen industry's capacity to develop and use new technology. Throughout the region, private sector spending on R&D is a tiny fraction of government spending. In Indonesia, for example, the figure is estimated at 20%. "The real issue is whether industry can accommodate and make proper use of the skills of the people coming out of the universities," says Katili. And Roger Posadas, former chancellor of the University of the Philippines, Diliman, and founder of that school's Technology Management Center, believes that until industry recognizes the importance of research, efforts to boost applied academic research efforts will be futile. "Even if [public research] budgets increase substantially, there will be no impact on the economy, because there is no demand for science and technology from the private sector," he says.

Although each country has a selection of carrots to try to get the private sector involved in research, they have generally had mixed success. Many private companies feel they have not yet reached a scale where they can afford much R&D. Indeed, governments are finding that there are few takers for some of the joint-venture grants. The Thailand Research Fund, for example, originally intended 50% of its funding to go to academic-industrial research, but because of the dearth of takers, the percentage has never risen above 10%.

Most observers agree that it will take a change of attitude on the part of both scientists and industrialists before the region's economies begin to reap the benefits of new technology. "In the U.S., you have the entrepreneurs to make it happen, to take the basic research and put it into a product," says Malaysia's Omar. "But this is not the mindset in the developing world."

–Jeffrey Mervis and Dennis Normile

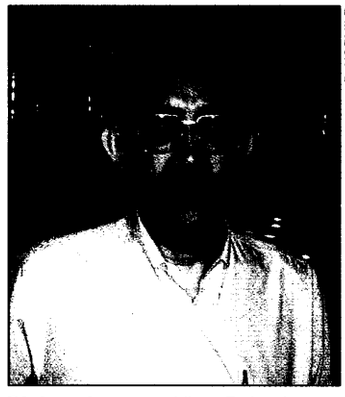
PROFILE

Securing a Niche for Basic Biology

BANGKOK, THAILAND—When the Thai government started talking a few years ago about turning its wealth of flora and fauna into a biotech cornucopia, biologist Visut Baimai pointed out a fundamental flaw in the approach: The country had only a rudimentary idea of what existed. So Baimai, a professor at Mahidol University, launched a yearlong effort to gather support for a special research fund. "We need to do basic biology before we can apply it to biotechnology or genetic engineering" became his mantra.

It worked. In 1996 Thailand set up the Biodiversity Research and Training Program and made Baimai its director, giving him $12 million over 5 years for competitively reviewed projects. The amount may not seem large, but Baimai, age 56, is ecstatic. "This sort of research had never before been supported by the Thai government," he says.

The 120 research projects funded so far are heavily focused on field surveys and taxonomy. "You can always come up with new species here," Baimai says. Several projects also focus on long-term ecological change, while some—in a nod to applicability—are screening organisms with potential commercial value. The program also supports 80 master's-level students and field workshops.


D. NORMILE

Biology booster. Visut Baimai says research precedes economic payoff.

The funding is especially sweet for Baimai, who earned his Ph.D. in genetics from the University of Queensland in Australia and did postdoctoral work at the University of Hawaii after joining the Mahidol faculty in 1969. "Basic science hardly got any support," he says, and so he sometimes dipped into his own pocket to fund his research on fruit fly and mosquito population genetics. Despite that handicap, "he's got a lot of publications under his belt," says Vudhipong Techadamrongsin, the deputy director of the Thailand Research Fund, who calls Baimai one of the country's foremost biologists.

Baimai jokes that his prominence is due to the meager competition: "For fungi, for example, we don't have any experts at all in Thailand." To remedy that, Baimai hopes to create a more permanent fund for biology. "We'd like to see this activity go on for 5, 10, 20 years," he says, "and we're starting to talk about how to do it." –D.N.